APPENDIX 1
VEHICLE AND TEST INFORMATION

Test No.:	1250
Contract or Study Title:	SIDE IMPACT PROTECTION IN PRODUCTION VEHICLES
Test Performer:	TRANSPORT CANADA
Test Reference No.:	88-017
Test Type:	BASELINE TEST
Test Configuration:	IMPACTOR INTO VEHICLE
Closing Speed (kph):	50.2
Impact Angle (degrees):	270
Offset Distance (mm):	0
Version No.:	1
Test Objectives:	SIDE IMPACT RESEARCH
Test Date:	15-SEP-88
Contract No.:	
Test Track Surface:	CONCRETE
Test Track Condition:	DRY
Ambient Temperature (degrees Celsius):	13.887
Type of Recorder:	FM MULTIPLEXOR TAPE RECORDER
Side Impact Point (in mm):	-514.401
Total No. of Curves:	40
Test Commentary:	NO COMMENTS
VEHICLE INFORMATION:	
Vehicle No.:	2
Vehicle Make:	FORD
Vehicle Model:	TAURUS
Model Year:	1988
Engine Type:	V6 INLINE FRONT
Engine Displacement (liters):	3
Vehicle Test Weight (Kgrams):	1642.005
Vehicle Length (mm):	4791.634
Vehicle Width (mm):	1809.369
Body Type:	FOUR DOOR SEDAN
Vehicle Identification No.:	1FABP5OUXJG128782
Transmission Type:	AUTOMATIC - FRONT WHEEL DRIVE

APPENDIX 2
BROAD APPROXIMATIONS TO INJURY STATISTICS

Exact correlations to injury statistics are not possible for the new architecture. However, this section attempts to provide an indication of possible benefits in the new system in terms of the incidence of AIS 3+ injuries.

Rouhana and Foster (13) provides data on injuries from Car-Car side impact from NCSS accident data which is reproduced below. This analysis differs from that of Viano (14), of the same data in that we have a totally different architecture and do not perform analysis relative to thoractic viscous compression. Our analysis assumes that the injury is produced by the peak acceleration of the thorax.

Calibrating the table provided by Rouhana and Foster to the measured peak thoractic acceleration of 67Gs or 656 M/s/s in the test considered in this paper assuming linearity in the correlation and setting the Mean delta V to about 60% of 50.3 km/h or 8.38 m/s, gives an AIS 3+ percentage of about 9.0 % from the table1. The Millennium System peak thoractic acceleration is 29 Gs or 284 m/s/s which corresponds to 43% of the peak acceleration of the conventional architecture that should correspond with 43% of the "equivalent" mean delta V in terms of injury impact for this architecture or 3.6m/s which results in a AIS 3+ of about 2 % . **This represents a 77% drop in AIS3 + injuries.**

Table 1

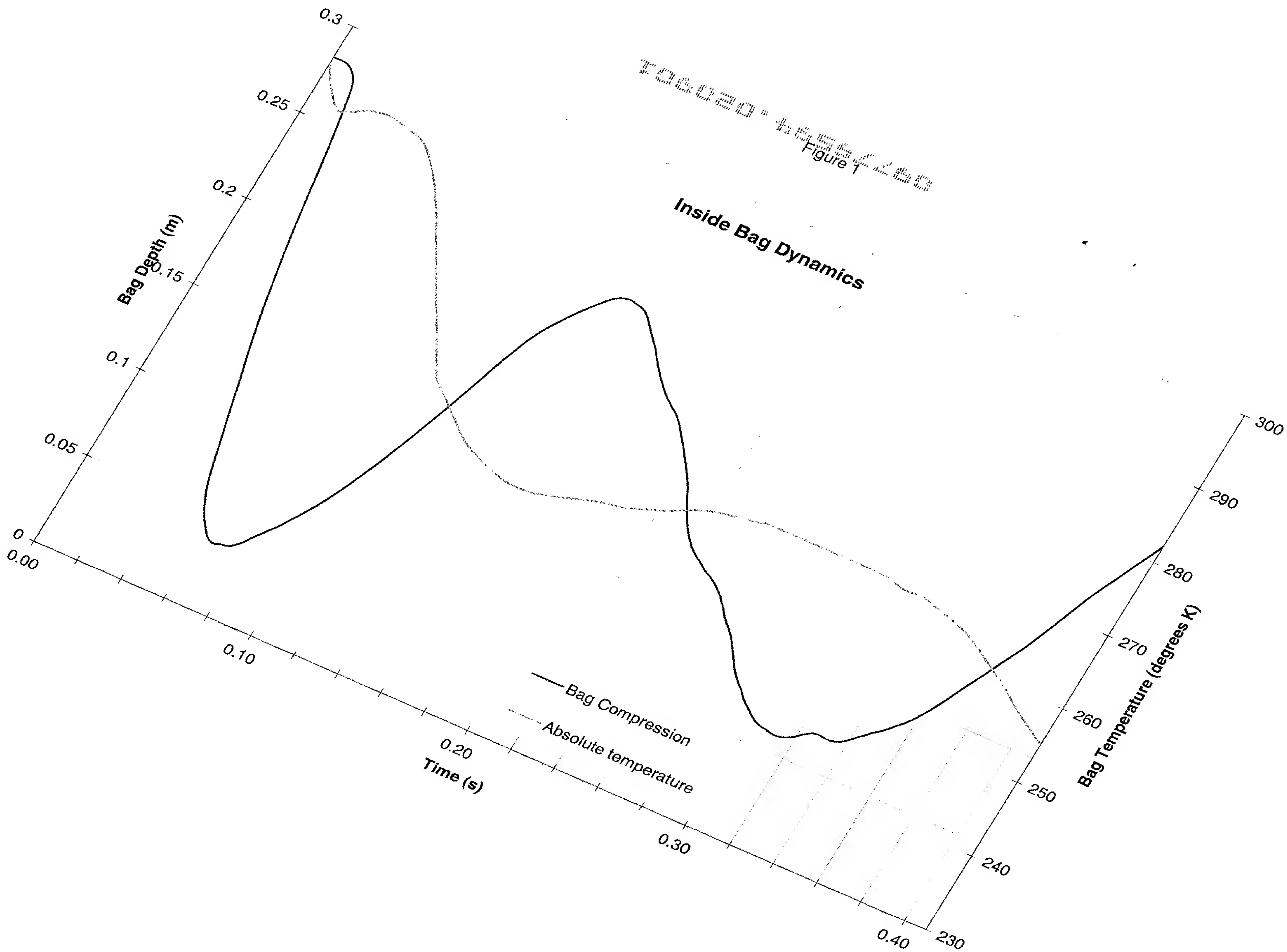
Mean Delta V	Possible injury exposure		Injuries AIS 3+	
M/s	Number	%	Number	%
1.35	98	1.62	3	3.06
2.7	680	11.24	10	1.47
4.05	1222	20.2	28	2.29
5.4	1283	21.2	70	5.46
6.75	1049	17.34	62	5.91
8.1	866	14.31	77	8.89
9.45	341	5.64	33	9.68
10.8	142	2.35	11	7.75
12.15	151	2.5	24	15.89
13.56	86	1.42	36	41.86
14.85	62	1.02	22	35.48
16.2	33	.55	5	15.15
17.55	21	.35	3	14.29
18.9	17	.28	12	70.59
20.25	0	0	0	0

REFERENCES

1. National Highway Traffic Safety Administration, Traffic Safety Facts, 1997.
2. National Highway Traffic Safety Administration, Fatal Accident Reporting System, 1980.
3. National Highway Traffic Safety Administrationg, Federal Motor Vehicle Safety Standard 214, Code of Federal Regulations Title 49, Part 571.214. The Code is published annualy by the Superintendant of Documants, U.S. Government Printing Office, Wahington, DC, with NHTSA standards in the volume â€œTitle 49, Parts 400 - 999.â€□
4. Byron Block Advanced Designs for Side Impact Protection, 16th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Volume 3, pages 1778 - 792, NHTSA Technical Report DOT HS 808 759, October, 1998 This is availablefrom the National Technical Information Service, Arlington, Virginia.
5. Hansun Chan, James R. Hackney, Richard M. Morgan, and Heather E. Smith, An Analysis of NCAP Side Impact Crash Data, Volume 3, pages 2490 - 2502, 16th ESU, NHTSA Technical Report DOT HS 808 759, October, 1998.
6. Carl C. Clark, Human Transportation Fatalities and Protection Against Rear and Side Crash Loads by the Irstop Restraint, Proceedings of the 6th Stapp Car Crash Conference, 1965, University of Minnesota Press, 1996.
7. Charles F. Warner (Collision Safety Engineering, Oren, Utah), Inflatable Structures for Enhanced Side Impact Crash Protection, Final Report of the Small Business Innovative Research contract #DTRS-57-87-C-00089, April, 1988.
8. Carl C. Clark and William A. Young, Airbag Bumpers Inflated Just Before the Crash, Society of automotive Engineers Technical Paper SAE 841051, March, 1994.
9. Carl C. Clark and William A. Young, Car Crash Theory and Tests of Airbag Bumper Systems, SAE 951056, March, 1995.
10. Rajasingham., A.I. Unpublished research 1993-2000 prior to pending patents.
11. Robert L. Carter, Passive Protection at 50 Miles Per Hour, NHTSA Technical Report DOT HS 810 197, June, 1972.
12. Claes Tingvall, Anders Lie," the indications of the zero vision on biomechanics Research". International IRCOBI Conference on the Biomechanics of Injury, December 1996.
13. Rauhana , SW and Foster, M.E., "Lateral impact – An analaysis of of the statistics in the NCSS" SAE 851727, 1985.
14. Viano David. C. "Evaluation of the benefits of Energy Absorbing Materials in Side impact Protection: Part-1" . SAE 872212 . 1987.
15. Articulated Total Body (ATB). US Airforce. Wight Patterson Airforce Base. 1999.

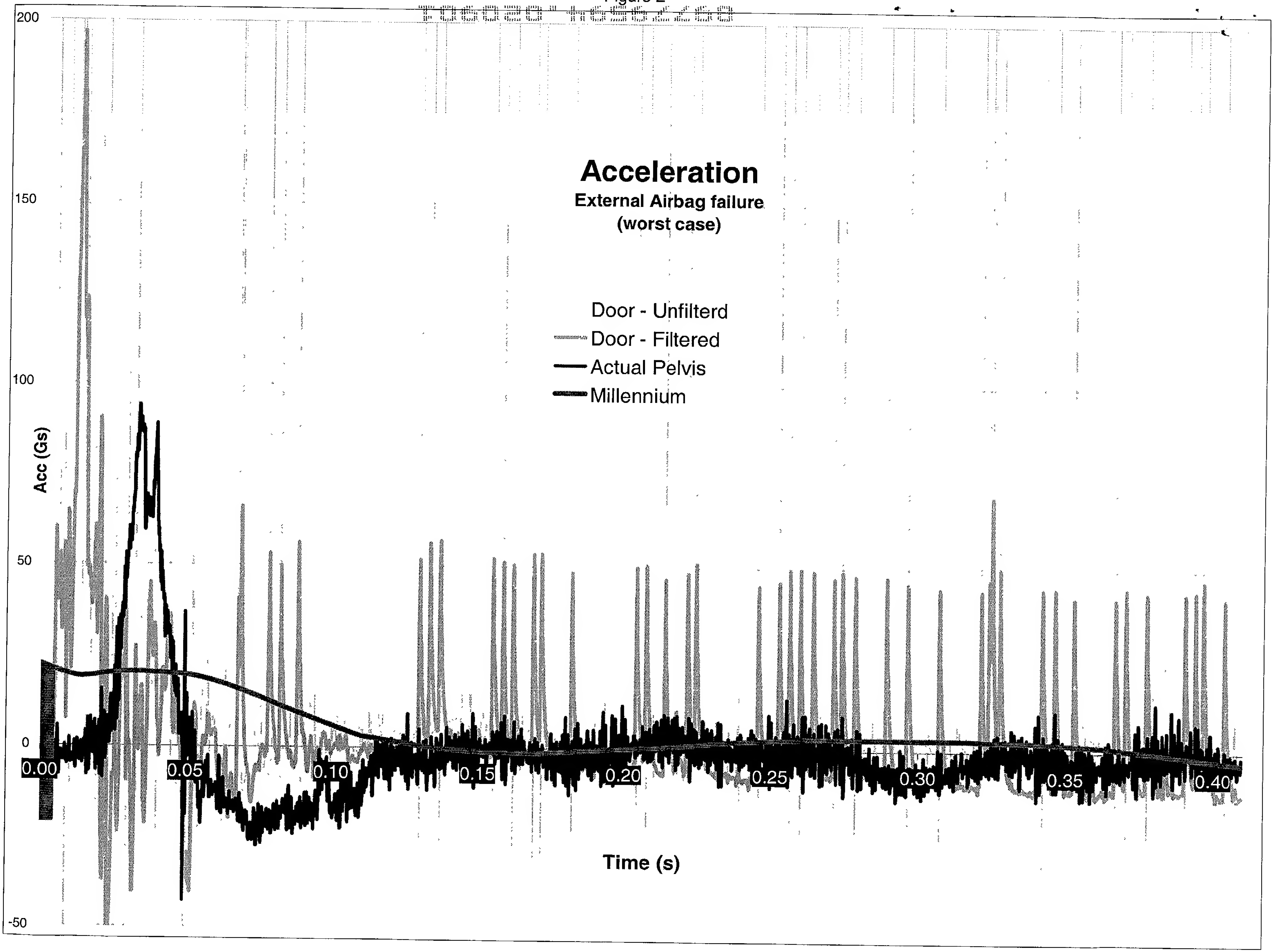
ILLUSTRATION-1.

Figure 1



Inside Bag Dynamics
Bag Depth (m)
0
0.05
0.1
0.15
0.2
0.25
0.3
Time (s)
0.00
0.10
0.20
0.30
0.40
Bag Temperature (degrees K)
230
240
250
260
270
280
290
300
Bag Compression
Absolute temperature

Figure 2



Acceleration
External Airbag failure
(worst case)
Door - Unfilterd
Door - Filtered
Actual Pelvis
Millennium
Acc (Gs)
200
150
100
50
0
-50
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Time (s)

P15

Figure 3

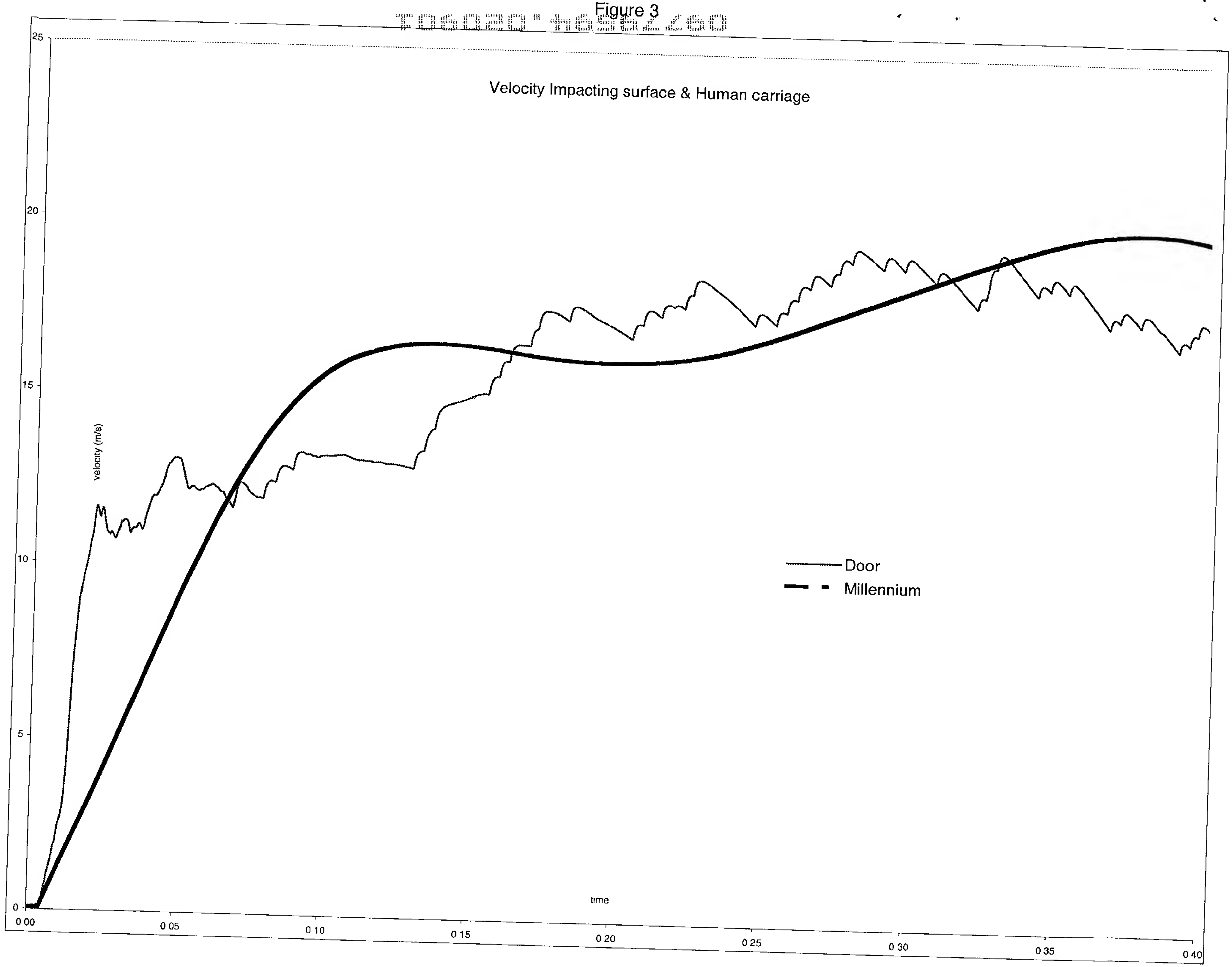

Velocity Impacting surface & Human carriage
velocity (m/s)
25
20
15
10
5
0
time
0 00
0 05
0 10
0 15
0 20
0 25
0 30
0 35
0 40
Door
Millennium

Figure 4

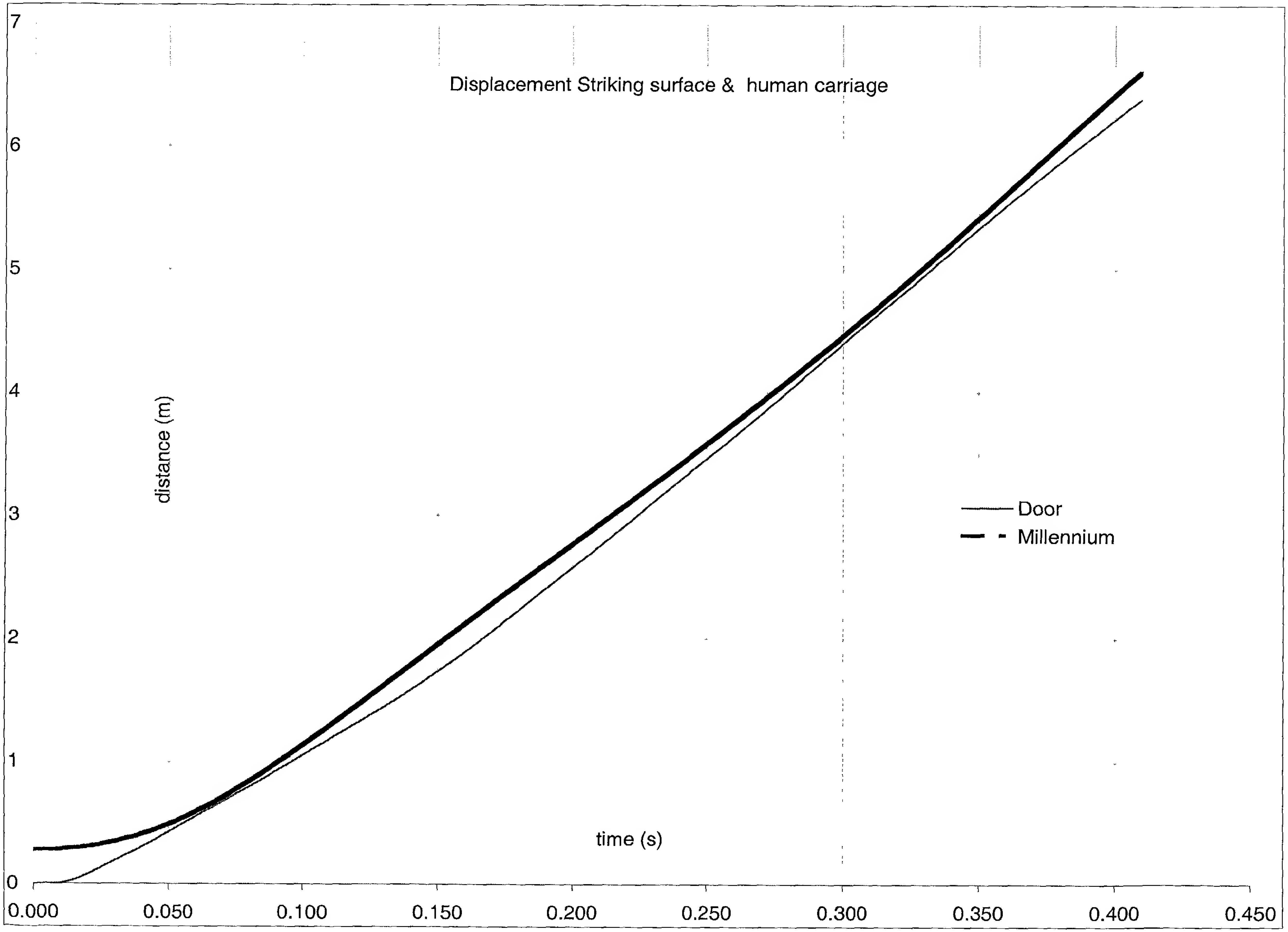

Displacement Striking surface & human carriage
distance (m)
time (s)
Door
Millennium
7
6
5
4
3
2
1
0
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450

Figure 5A

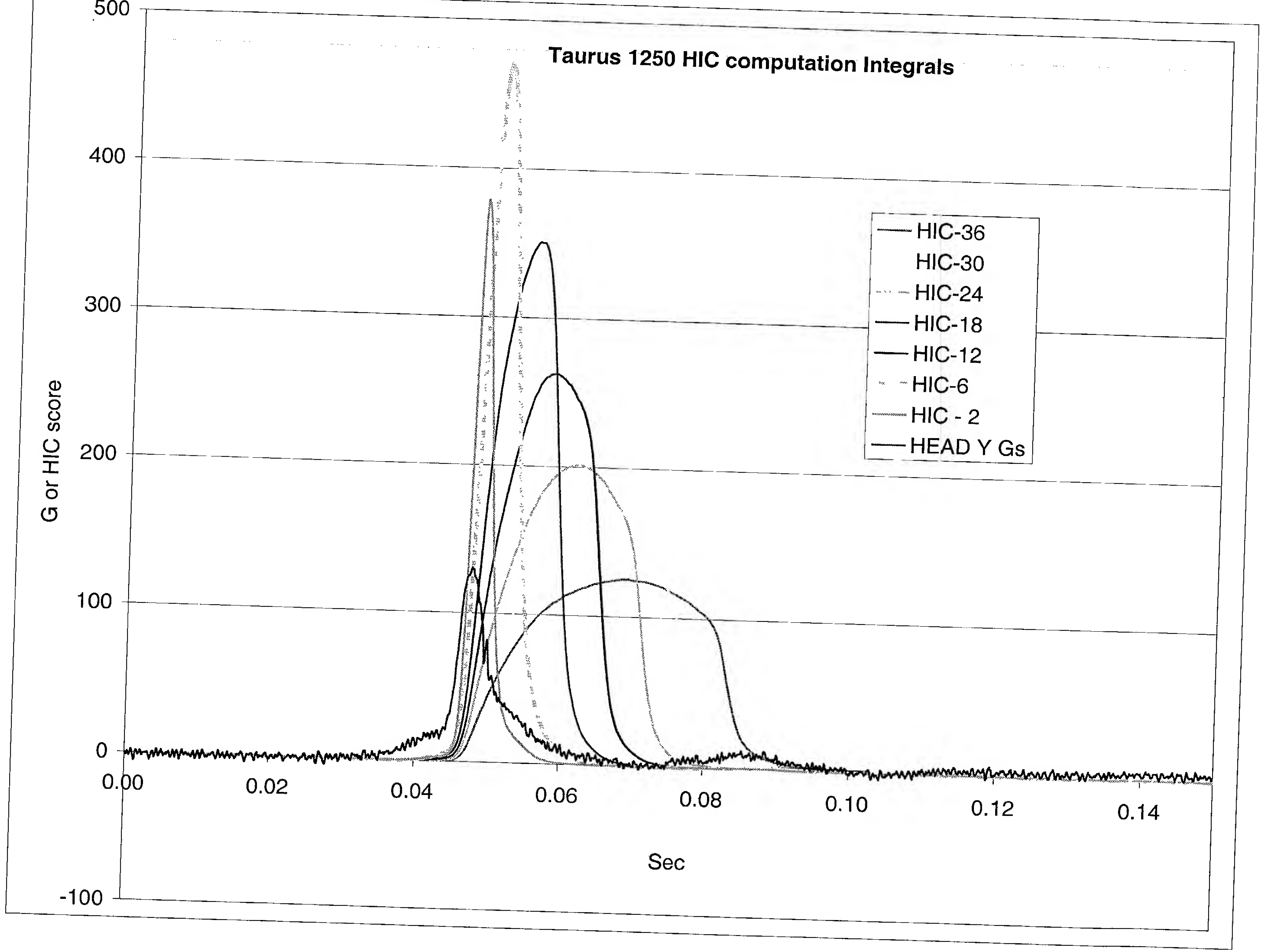

Taurus 1250 HIC computation Integrals
G or HIC score
500
400
300
200
100
0
-100
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Sec
HIC-36
HIC-30
HIC-24
HIC-18
HIC-12
HIC-6
HIC - 2
HEAD Y Gs

Figure 5

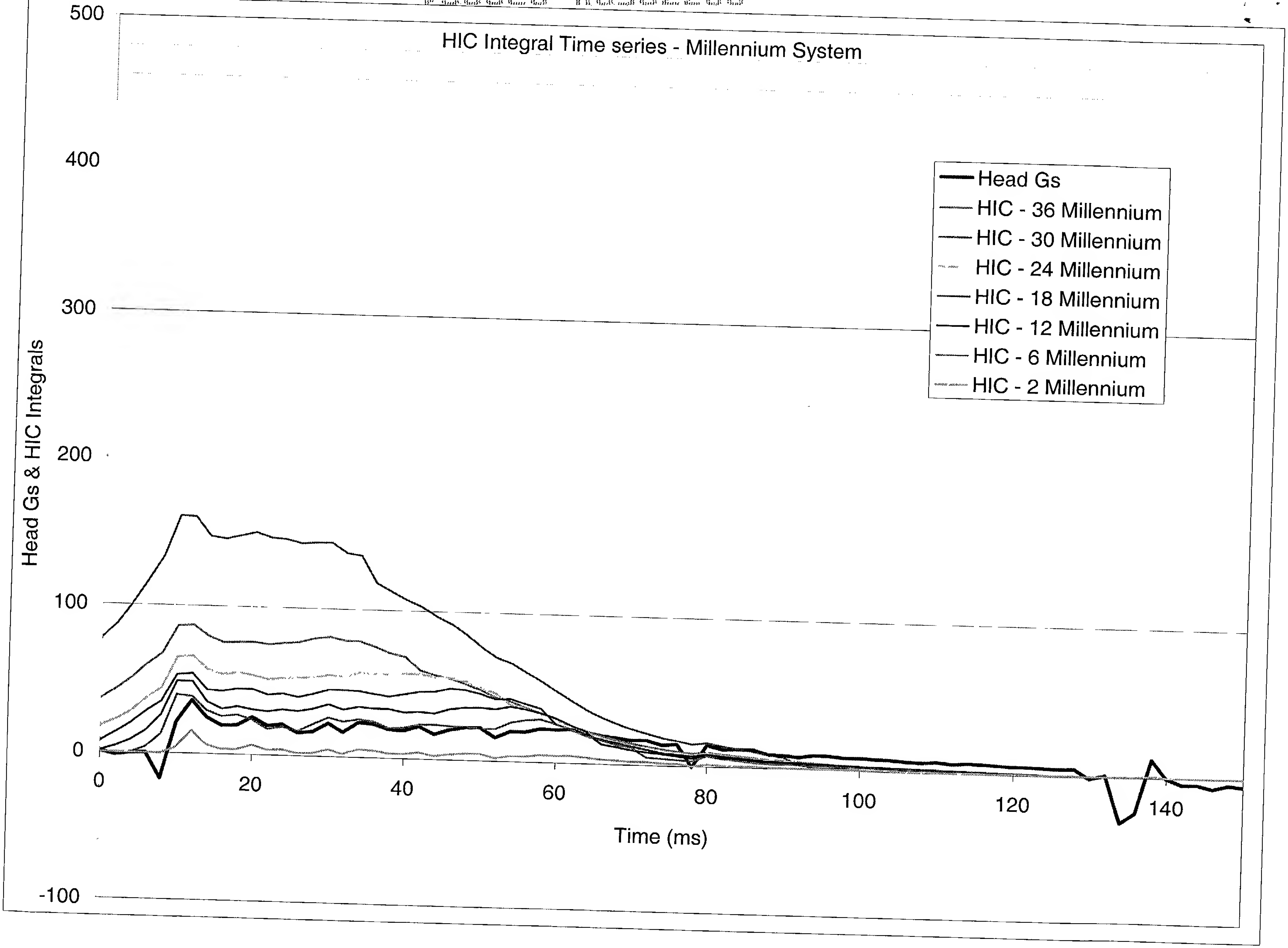

HIC Integral Time series - Millennium System
Head Gs & HIC Integrals
Time (ms)
500
400
300
200
100
0
-100
0
20
40
60
80
100
120
140
Head Gs
HIC - 36 Millennium
HIC - 30 Millennium
HIC - 24 Millennium
HIC - 18 Millennium
HIC - 12 Millennium
HIC - 6 Millennium
HIC - 2 Millennium

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Figure 6

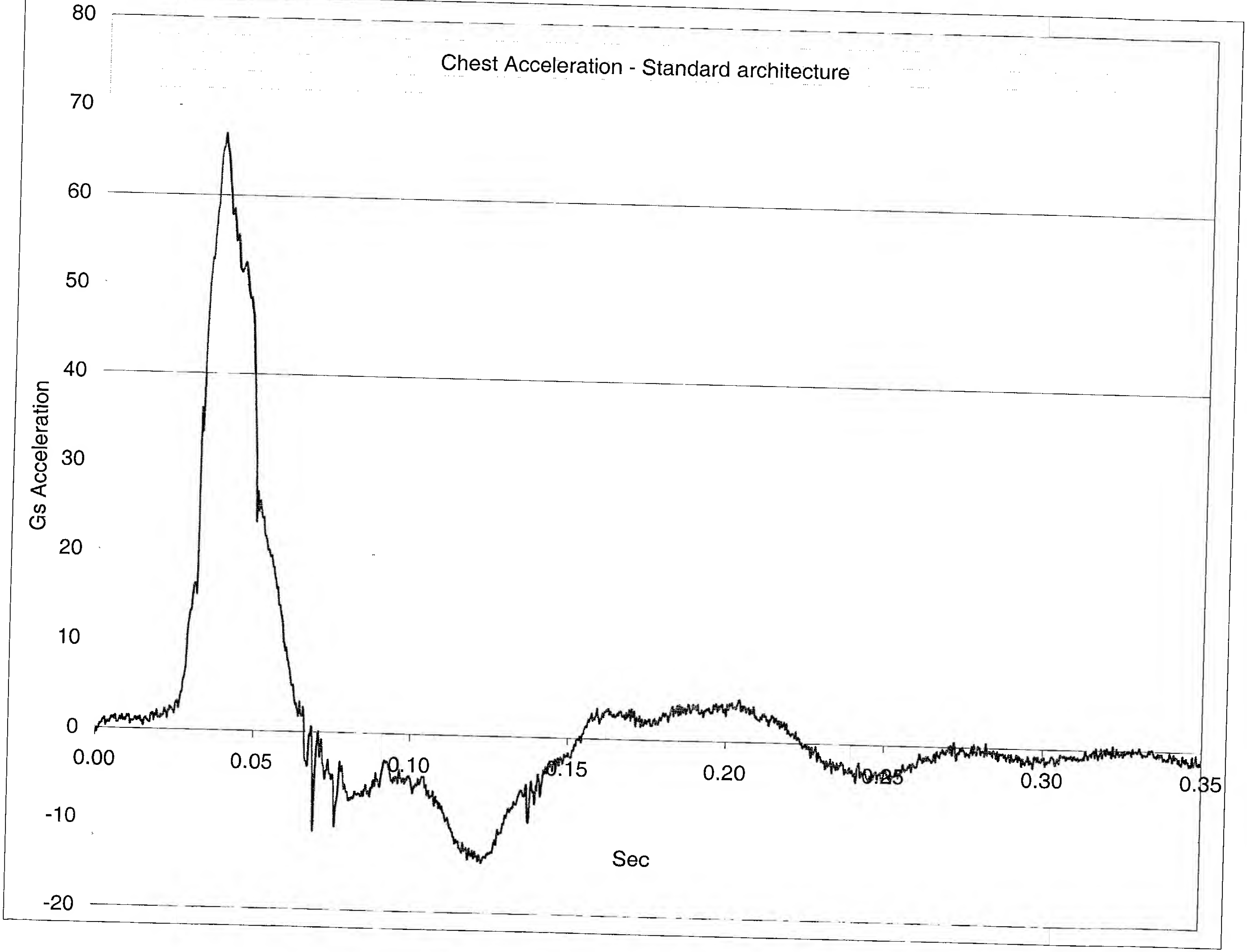
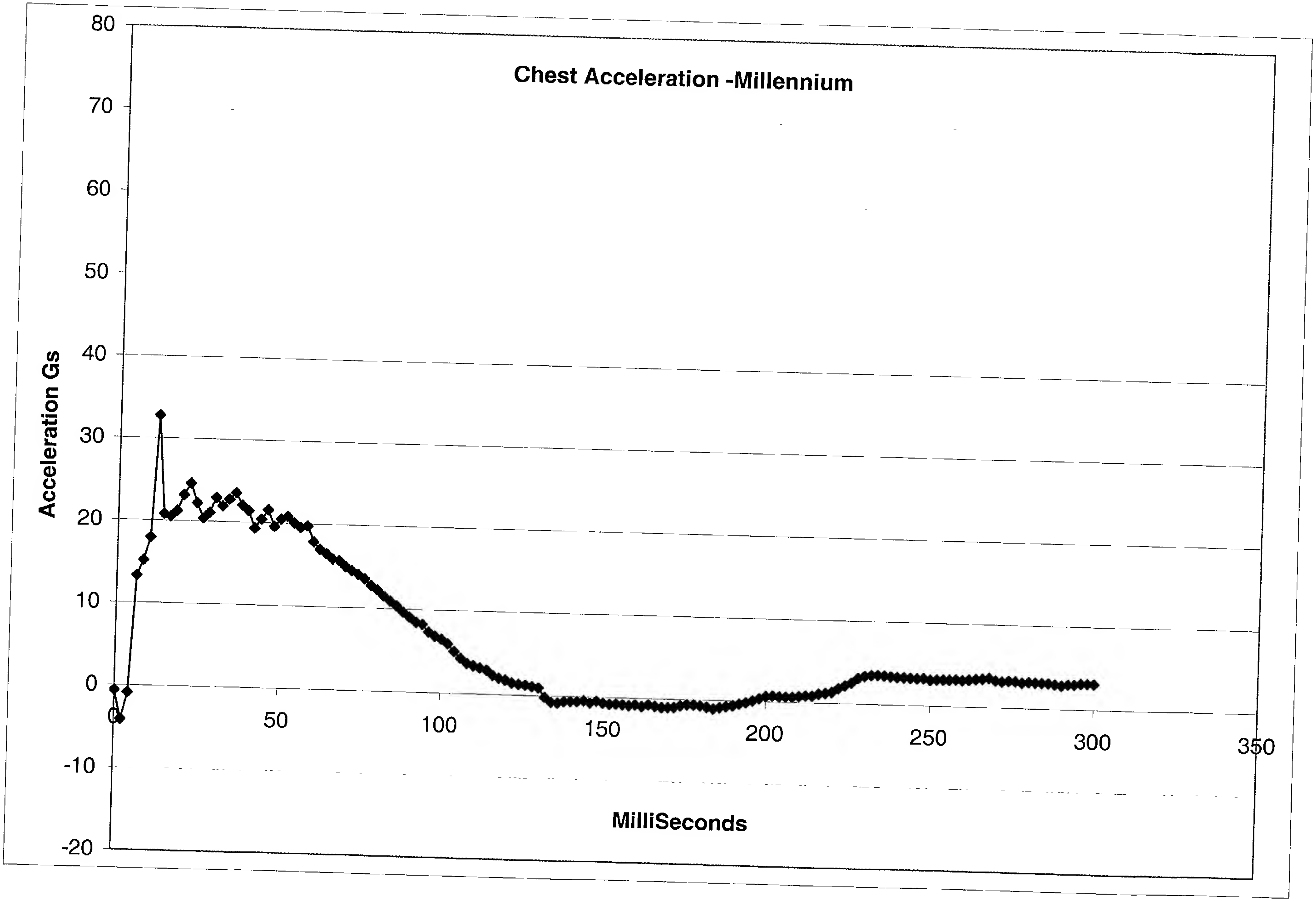

Chest Acceleration - Standard architecture
Gs Acceleration
80
70
60
50
40
30
20
10
0
-10
-20
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Sec

FIG 6-A


Chest Acceleration -Millennium
80
70
60
50
40
30
20
10
0
-10
-20
Acceleration Gs
0
50
100
150
200
250
300
350
MilliSeconds